

The use of mustard to estimate earthworm populations

A. GUNN

Synopsis: Original scientific paper

The efficiency of mustard as a vermifuge for estimating earthworm populations or collecting earthworms for laboratory studies was compared with that of formalin, potassium permanganate and household detergent. Mustard was shown to be as efficient as potassium permanganate and both these substances were better than formalin. Household detergent was an extremely poor vermifuge. Mustard does not kill earthworms as does potassium permanganate, and unlike formalin it is not carcinogenic and does not have phytotoxic effects on clover. Mustard would therefore appear to be an ideal "environmentally friendly" means of estimating earthworm populations and for collecting healthy worms for laboratory studies in areas where soil sampling is not feasible due to the damage it would cause.

Keywords: Earthworm, Lumbricidae, Oligochaeta, vermifuge, mustard, emulsion.

1. Introduction

Handsorting soil samples is the most accurate means of estimating earthworm populations (SACHELL, 1971) but it is a very laborious procedure and its efficiency is reduced when the soil has a high clay content or if there is a dense root mat present. Soil sampling also damages the land and this is frequently unacceptable in parks, bowling greens or playing fields. In these situations a vermifuge is needed, formalin and potassium permanganate being the most commonly used (SPRINGETT, 1981). Formalin is carcinogenic and will kill clover plants in the treated area (unpubl. obs.) it also kills the worms unless they are thoroughly washed immediately after emerging from the ground. Potassium permanganate stains the grass and is extremely toxic to earthworms so that many worms die even if they are washed immediately (pers. obs.). It is therefore highly probable that the application of potassium permanganate has a very harmful effect on the soil fauna. This paper investigates the use of mustard as an alternative non-toxic vermifuge for estimating earthworm populations or simply for collecting worms for laboratory studies.

2. Method

In an attempt to find the optimum mustard concentration water suspensions of English Mustard (ready mixed emulsion) were prepared of between 5 and 25 ml per l. The suspensions were applied evenly with a watering can to one metre square quadrats of closely mown park grassland. The soil was a uniform heavy clay loam. Quadrats were separated by a minimum distance of one metre emerging during ten minutes were collected; about 90% of them emerged within the first five minutes. All the concentrations were tested on the same day. As the mustard used in these experiments was bought as a ready prepared emulsion it contained several additives foremost amongst which was vinegar. In a separate trial the efficiency of the mustard emulsion (15 ml l^{-1}) was therefore compared with that of vinegar (15 ml l^{-1}). Ten litres of each was used per quadrat.

Based on this study the efficiency of a 15 ml l^{-1} suspension of mustard was compared with that of other vermifuges. This concentration was chosen as it gave good results, and the mustard did not

coagulate before it could be applied (as happened at higher concentrations). The other vermifuges were formalin (5 ml of commercial grade 40% formalin in 1000 ml water (0.2%)), potassium permanganate (2 g l^{-1}) and household detergent (15 ml l^{-1}). The concentrations of formalin and potassium permanganate followed SPRINGETT (1981); household detergent was recommended as another possible non-toxic vermifuge by local anglers. All the vermifuges were tested on the same date and on land not previously used for experimentation. Ten litres of each were used per quadrat. The results were compared using ANOVA.

3. Results

The mustard concentration extracting most worms could not be determined as the number of worms recovered increased with mustard concentration (table 1) beyond the point at which the mustard suspension formed large glutinous coagulations before it could be applied. Vinegar had extremely poor vermifugal activity, extracting only 0.5 ± 0.34 worms m^{-2} ($n = 6$), compared with that of the mustard, 21.8 ± 1.58 worms m^{-2} ($n = 6$).

Table 1. The comparative efficiencies of various concentrations of mustard for extracting earthworms from a park grassland.

Concentration of mustard (ml l^{-1})	Number of replicates	Number of earthworms extracted (mean \pm standard error)
50	5	5.8 ± 1.65
100	5	17.0 ± 3.70
150	5	45.2 ± 5.32
250	4	114.2 ± 8.86

Note: 10 l of mustard suspension were applied to individual 1 m^2 quadrats.

In the comparative study (table 2) no significant difference ($P > 0.05$) was found between the efficiency of mustard and potassium permanganate although both brought significantly more worms to the surface than did formalin (mustard $P < 0.01$, potassium permanganate $P < 0.05$) or household detergent ($P < 0.005$). Formalin was more efficient than household detergent ($P < 0.005$) which had virtually no effect as a vermifuge.

Table 2. The comparative efficiency of mustard as a vermifuge, compared with formalin, potassium permanganate and household detergent.

Treatment	Number of replicates	Number of earthworms extracted (mean \pm standard error)
Mustard (15 ml l^{-1})	6	29.0 ± 4.09
Formalin (0.2%)	6	12.5 ± 2.53
Potassium permanganate (2 g l^{-1})	6	25.5 ± 3.64
Household detergent (15 ml l^{-1})	6	0.7 ± 0.21

Note: 10 l of each vermifuge were applied to individual 1 m^2 quadrats.

4. Discussion and conclusions

These results demonstrate that mustard is an extremely good vermifuge and has the added advantage of being non-toxic. Thirty worms collected after mustard treatment were washed and kept in the laboratory for observation; all were still alive and healthy after 48 hours. Similarly no phytotoxic effects have been found while using mustard in the field or in laboratory experiments on potted clover and Italian rye grass. This is in contrast to formalin which killed the clover in those areas where it was used as a vermifuge. The phytotoxic effects of formalin were confirmed in laboratory experiments on potted clover plants; all the plants were killed by the concentrations used in vermifugal preparations. The difficulty in re-establishing clover on land previously treated with formalin suggested that it also has a residual effect in the soil (unpub. obs.). Other advantages of mustard include cheapness, ready availability without a license, simplicity of application and very rapid effects. Mustard was also very good at bringing to the surface enchytraeids and slugs, including *Boettgerilla palens* which is normally seldom seen due to its subterranean lifestyle. No attempt was made in this study to assess the efficacy of recovery of these animals.

5. Acknowledgements

This work forms part of a project supported by the Agricultural and Food Research Council.

6. References

- SATCHELL, J. E., 1971. Measuring population and energy flow in earthworms. In: J. PHILLIPSON (ed.). Methods of study in soil ecology. UNESCO. 261–267.
- SPRINGETT, J. A., 1981. A new method for extracting earthworms from soil cores, with a comparison of four commonly used methods for estimating earthworm populations. *Pedobiologia* **21**, 217–222.

Address of the author: School of Biological Sciences, University College of North Wales, Bangor, Gwynedd, LL57 2UW, U.K.